volume contains a great many useful observations and a very lucid and stimulating review of the subject. One may question whether the biological influences have quite the dominating importance in the soil that is here claimed for them, and in particular whether the organisms found in it can as yet be satisfactorily used as a criterion of the agricultural properties of a soil; but the subject is still young and its possibilities are undoubtedly great.

The Presentation of Thermodynamics.

Vorlesungen über Thermodynamik. Von Prof. Dr. Max Planck. Sechste Auflage. Pp. x + 292. (Berlin: W. De Gruyter und Co., 1921.)

ONE of the most universal generalisations that can be made about the study of mathematical physics is that everybody finds thermodynamics a very difficult subject. In consequence of this there have arisen several different ways of presenting it, which vary far more from one another than do the presentations in such subjects as dynamics or electricity. There is first the thermodynamics of the engineer, in which entropy is something steam has, which can be found from tables. Then there is the thermodynamics of the chemist, whose laboratory is stocked with semipermeable membranes. He is a great designer of engines, but all his enjoyment of his wonderful instruments is spoiled by his perpetual suspicion that Nature is trying to score off him. Next, there is the thermodynamics of the mathematician; this scraps the chemist's machinery and does the whole business by means of Pfaffian forms, a peculiar branch of mathematics, and almost the only one in which it looks as if more comes out at the end than is put in at the beginning. Lastly, there is the super-man, who can see and count the atoms, who regards all the others as gamblers, though he is bound to admit that they know how to lay the odds. He occupies a position rather apart, being, so to speak, engaged in a study of the jurisprudence of thermodynamics.

Now (excepting the last), all these presentations claim to derive their results from the two laws of thermodynamics, but there is no agreed statement of those two laws. In most books the chapter on the Second Law is not opened by a formal statement of that law—as Newton's laws of motion would head the corresponding chapter in a book on dynamics—but it is necessary to have several pages of tendencious discussion first, to create the atmosphere in which the law shall be acceptable. This can only mean that the law as stated contains a good many implied assumptions. Some years ago Carathéodory, the pure mathematician, formulated the principles in a really logical manner, and it is to be hoped—if we can believe that the human mind is by taste rational—that this formulation will be more successful in making the subject easy than has the exceptional variety in presentation which has hitherto prevailed. Carathéodory's work was transcribed a year or two ago in the *Physikalische Zeitschrift* by Born. He insists that there is no way of shirking the Pfaffian problem in some form or other, but gives a simple geometrical description of it; in the consequent deduction of absolute temperature and entropy there is some rather heavy work which could probably be simplified. But the most important modification is the new place taken by temperature in the presentation. In the ordinary way it occurs muddled up with the Second Law, but here it is taken out and introduced as the primitive idea—of course, measured on an arbitrary scale. The consequence is that the First Law no longer deals with quantities which are undefined, and the Second Law becomes a clear-cut statement instead of a jumble of two statements.

The new presentation is too recent to have been adopted in text-books, and it will be most interesting to see whether it is destined to drive out the older types. The book under review is of a class about midway between those of the chemist and those of the mathematician. That it has gone through six editions shows that it is a first-rate introduction to the subject; but it certainly can be criticised from the logical point of view, for it brings in absolute temperature by means of the perfect gas, and only later justifies it in the general case. It is a philosophical question whether it is legitimate to introduce ideas connected with reality by means of a hypothetical substance—perhaps it may be defended, like the introduction of rigid bodies in dynamics. But the point really is that this method is apt to leave the student with the idea that absolute temperature is in some way connected with perfect gases, an idea rather encouraged by many of the examples that are usually cited. It is surely a pity to start by dealing with a special case, when the whole argument is that Carnot's cycle works exactly as well whatever the substance in the cylinder. Apart from this criticism, however, the whole work is an admirably detailed development of the theory, with numerous illustrative examples from physical chemistry. The chief changes in the new edition are in connexion with the theory of solutions; in particular, an account is given of the theory of J. C. Ghosh of Calcutta, of the freezing-points of strong solutions, which would seem to have attracted more attention in Germany than in this country. There is also more said about the equation of state of solids and their expansion coefficients.

©1922 Nature Publishing Group

We have dwelt perhaps with undue weight on the question of fundamentals, because this seems to us a matter which should be put right. But the present work, supplemented by a proper treatment of those fundamentals, certainly constitutes an excellent course in the general theory of thermodynamics.

Dialectic.

Studies in the Hegelian Dialectic. By Dr. John McT. E. McTaggart. Second edition. Pp. xvi + 255. (Cambridge: At the University Press, 1922.) 15*s.* net.

IT is curious that a book which professed only to be a study of Hegel, and deals with criticisms of the Hegelian method and principle current more than thirty years ago, should be reprinted to-day and present the same freshness and vigour to the reader now as it did then. This is the feeling with which one who read Dr. McTaggart's book on its first appearance now lays it down, having read it again from beginning to end. It contains the best exposition of the dialectic, and the best defence of the dialectic, and the best criticism of it by any living writer. The conclusion Dr. McTaggart reaches would be accepted probably even by the most convinced Hegelians, namely, the conclusion that the logic is of permanent value and the dialectic sound, but that the metaphysic is unsatisfactory and cannot be final. His own view would seem to be that the ultimate reality is a unity of personalities, but that this unity is not itself a personality. Most of this book was originally presented in papers read and discussed at the Aristotelian Society in the early 'nineties and published in *Mind,* for at that time the Society did not publish Proceedings. It is a living work to-day because, more than at any previous time, the problem of the methodology of science is in the forefront. Mathematical discoveries, which have caused a revolution in our mode of conceiving the physical universe, and the discoveries of the new psychology, which have profoundly changed our mode of conceiving the mind, have necessitated a reconsideration of what is implied in the experimental method. We have found a need for dialectic, for the logic of philosophy. The stone which was set at nought by the scientific builders of the nineteenth century is become the head of the corner.

In the thirty years which have elapsed since Dr. McTaggart's book was written there have been some notable attempts in philosophy to reform and advance the Hegelian dialectic. It would be interesting to know Dr. McTaggart's attitude towards them. In section 120 he seems almost to anticipate Croce's criticism of Hegel as failing to differentiate between "opposites" and "distincts." Also one would like to know how far he considers that Gentile, in the theory he has worked out of the identity of philosophy with its history, has met his objection to the place assigned by Hegel to philosophy in the supreme triad of absolute mind. Dr. McTaggart's own recent work, "The Nature of Existence," gives the impression that he has himself moved away from the position of these early studies and has fallen under the spell of the opposite method to that of the dialectic, the method which is known as logistic and has its home in his college. It may be, however, that he is illustrating in his own mental development the dialectical advance through negation. In any case we can say that this republication of his early work is of the greatest value to those who are endeavouring to follow the constructive work in which he is now engaged.

H. WILDON CARR.

The Methods of Ecological Investigation.

Geobotanische Untersuchungsmethoden. Von Prof. Dr. Eduard Rübel. Pp. xii + 290. (Berlin: Gebrüder Borntraeger, 1922.) 16*s.* 8*d.*

IT is now seventeen years since the first appearance of Prof. Clement's work on "Research Methods in Ecology," written at a time when this branch of knowledge was still in its infancy and its methods for the most part yet to be devised. Since 1905, however, considerable advances have been made, particularly in the two directions of intensive study of the habitat factors and the extensive study of the plant community.

The growth of the subject is indicated by the establishment, both in this country and in America, of specialised journals devoted to this field alone, and this growth has naturally been accompanied by the development of a definite technique for the study of plant societies. We therefore welcome the work before us, in which Prof. Rübel has aimed at giving us a survey of the present position of ecological methodology on the botanical side.

Broadly the subject matter falls into two sections corresponding to the two main lines of progress already mentioned. Of these the consideration of the factors of the habitat, climatic, edaphic, biotic and orographic, with the methods of their measurement, occupies nearly half the text.

The climatic section contains a useful account of several American types of atmometer, methods of measuring light intensity under water, etc. The section treating of edaphic factors is regrettably short, especially having regard to the extensive development in this direction. For example, details might usefully have been furnished of the freezing-point depression methods of estimating the concentration of soil solutions

©1922 Nature Publishing Group